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01 May 2009

Version of attached file:

Published Version

Peer-review status of attached file:

Peer-reviewed

Citation for published item:

MacMahon, A. and Price, J. (2005) 'Glass-working and glassworkers in cities and towns.', in Roman working lives and urban living. Oxford: Oxbow Books, pp. 167-190.

Further information on publisher's website:

<http://www.oxbowbooks.com/bookinfo.cfm/ID/44514//Location/Oxbow>

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Glass-working and glassworkers in cities and towns

*Jennifer Price***Introduction**

Glass held an unusual position among the manufactured goods of the Roman world as it was essentially novel, becoming widely used for everyday purposes only after the invention of glass blowing in the mid-first century BC. Small decorated core-formed containers, open sagged tablewares and moulded inlays were produced in different areas of the eastern Mediterranean region in the middle and late Hellenistic periods. Some of these reached cities and towns in the western Mediterranean region and further afield, but no substantial tradition of working and using vessel glass developed in Italy or the western provinces until the last years of the Roman Republic. At around this time, Roman literature began to include comments on the appearance and qualities of glass, and glass vessels appeared in wall-paintings in Rome and the Vesuvian towns (Naumann-Steckner 1991; 1999).

The surviving archaeological, textual and iconographic evidence shows that glass had many functions in the cities and towns of the Roman empire. The range of vessels included tablewares for displaying, serving and consuming liquids and solid foodstuffs, and household wares and containers for storing and transporting liquid and semi-liquid foodstuffs and cosmetic and medical preparations. It was also used to make items of jewellery, as well as counters and gaming pieces, figurines and elements of statues and many other objects. In addition, it frequently featured in public and private architectural schemes, for windows and for the decoration of floors, walls, vaults and furniture.

The reasons for adopting glass must have varied in different parts of the Roman world in the early imperial period. The population of cities and towns in the eastern and Mediterranean provinces were presented with a much wider choice of forms of a material with which they were already familiar, whereas using glass in new and peripheral provinces like Germany or Britain may have had symbolic appeal to elements of provincial society as a quintessentially Roman material. For example, glass vessels were scarcely present in Britain before the Claudian conquest (Price 1996), but in the decades after AD 43 they rapidly became available in the emerging civil settlements at Colchester (Cool & Price 1995, 211–3) and elsewhere.

Glass was not essential for any specific function; acceptable alternatives were usually available, but it was a versatile material which could be formed into many shapes and decorated in many styles. It could be opaque, brilliantly coloured or completely transparent and was sometimes made in imitation of more costly materials such as obsidian or chalcedony or rock-crystal. Glass vessels had some practical advantages over their ceramic or metal equivalents, both as transport and household vessels and as tablewares. The contents could be seen, the flavours of the contents were not absorbed into the fabric of the vessels so they could be washed and reused, and the vessels themselves had no taste and therefore did not contaminate the contents. In a well-known dining scene, Trimalchio noted that glass vessels, unlike Corinthian bronze vessels, did not taste and if they were not so fragile he would prefer them to gold (Petronius *Satyricon* 15.50).

In this paper, the extent of urban glass production will be examined through the evidence for glass-working sites, the artisans involved in production, the retail outlets, and the glass in circulation, using information from the eastern Mediterranean as well as from Italy and the western provinces (Maps 1–2).

Working glass in cities and towns

Scientific analyses demonstrate the homogeneity of the composition of most Roman glass, suggesting widespread use of a limited number of sources of raw materials. Primary production (*i.e.* making glass from the basic raw materials, which were sand, soda and lime) and secondary production (*i.e.* forming objects and vessels from glass already made) appear to have been two different and often physically separated processes, the glass made at the primary sites being transported to secondary workshops throughout the empire (summarised in Freestone *et al.* 2000, 66–7).¹

Primary production sites with rectangular tank furnaces producing large amounts of glass have been recognised in Egypt, at Lake Maryut near Alexandria and Wadi Natrun, the source of much of the mineral soda in the ancient world (Nenna *et al.* 2000), and on the coast of Syria/Palestine between Apollonia and Akko (*Ptolemais*), close to the sand from the River Belus (Freestone *et al.* 2000). These sites, however, date from the sixth to seventh and later centuries, and analyses indicate that the glass they produced is unlikely to have been the source of the Roman glass in western Europe (Nenna *et al.* 2000, 105; Freestone *et al.* 2000, 72–4). The primary furnaces of the first to fifth centuries have yet to be identified, but a similar mode of separation between primary and secondary production is suggested by the presence of lumps of raw glass in ships wrecked in this period,² and at ports and coastal sites,³ and by evidence that they were transported overland.⁴

The secondary workshops in or close to cities and towns depended on reliable supplies of glass to produce objects and vessels for their markets. Much of this presumably arrived as lumps of raw glass, though another important source was waste and recycled glass. Various categories of waste glass, such as moiles, twisted rods, drips and trails and lumps of furnace waste (Figure 10.1), were generated in the workshops, and broken vessel or window glass was collected as cullet for remelting.⁵

¹ Evidence for primary production not separate from secondary production has been recorded at York (Jackson *et al.* 1998; Cool *et al.* 1999) and in the Hambach Forest, west of Cologne (Wedepohl *et al.* 2003).

² Blue-green glass lumps weighing 100kg came from a late first-century wreck near Mljet, an island off the Croatian coast (Radić & Jurišić 1993, 122 fig. 7.2), and second to third and fourth to fifth century wrecks in southern France have produced lumps of colourless, pale greenish glass and yellowish green glass (Foy 2000, 149–50).

³ As in Marseilles, the Gulf of Fos and Narbonne in southern France (Foy & Nenna 2001, 106–8).

⁴ A third-century reference in the Babylonian Talmud mentions pack-animals transporting lumps of glass (cited in Weinberg 1988, 25 fn. 2).

⁵ This material often survives in small amounts on working sites: *e.g.* the total amount of glass waste from the Romano-British workshops at Leicester, Mancetter and Wroxeter weighed 0.5kg, 1.0kg and 1.2kg respectively (Price & Cool 1991, 25–27, table 1). More substantial quantities have also been recorded, as in the mid first-century workshop at Avenches in Switzerland which produced more than 10kg of raw glass, waste and cullet (Amrein 2001, 17–40), and very large deposits have sometimes been found in pits; *e.g.* 33kg of waste and cullet came from a late first- or early second-century pit in Saintes,

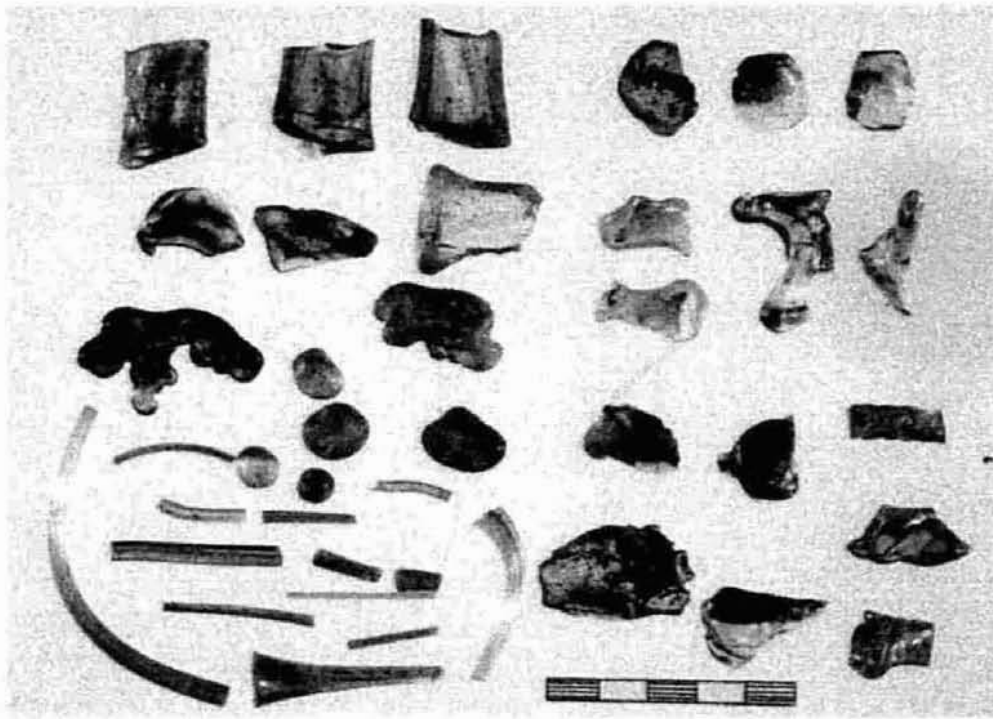


Figure 10.1 Waste glass and cullet from Mancetter, Warwickshire and Wroxeter, Shropshire (photo: University of Leeds Photographic Service)

The transport of cullet by sea is attested,⁶ but most waste glass and cullet was probably collected from the urban population in the vicinity of the workshops. Martial (*Epigrams* 1.41.1–5) and Statius (*Silvae* 1.6.70–74) note the practice of collecting broken glass in exchange for sulphur in Rome in the late first century (Leon 1941; Whitehouse 1999, 78–9), and similar activities presumably also took place in towns throughout the Roman world.⁷

There is some textual and epigraphic evidence for glass workshops in urban settlements. For example, an early fourth-century inscription mentioned a *clivus vitriarius* in Puteoli in Campania (Dessau 1892, 269 no. 1224b), and some of the evidence for glass-working in Rome has come from similar sources. The earliest is Strabo, writing in the Augustan period, who noted that many inventions in glass production in the city produced various colours and facilitated production (*Geography* 16.2.25), and two fourth-century catalogues of the structures and topographic features of the city, the *Notitia* and the *Curiosum Urbis Romae*, refer to a *vicus vitriarius* in Regio I between the Aventine and the Caelian hills (Nordh 1949, 73), probably situated along the first section of the Via Appia between Porta Capena and the Baths of Caracalla (Steinby 1999, 200). In addition, glass-working on the right bank of the River Tiber is assumed from Martial's account of a pedlar from that area who traded sulphur matches for broken glass (*Epigrams* 1.41.1–5).

south-west France (Amrein & Hochuli-Gysel 2000, 92–3) and 55 kilos of similar material came from an early-second century pit at Guildhall Yard, London (Pérez-Sala Rodés 2001, 66).

⁶ A wooden cask containing a large quantity of broken square bottles, plates, beakers and other glass vessels was part of the cargo of a second- or early third-century ship wrecked near Grado in north east Italy (Parker 1992, 197 no. 464; Giacobelli 1997)

⁷ Archaeological evidence for this practice is difficult to recognise, though marked differences in the numbers and size of glass fragments found in urban settlements at different periods sometimes suggests episodes of deliberate collection.

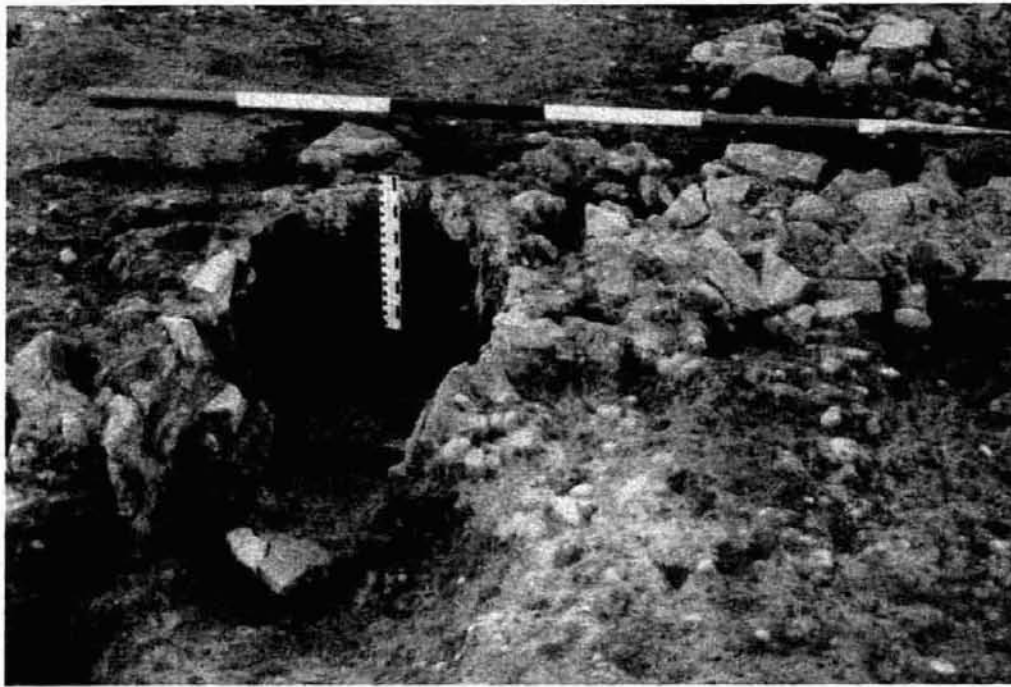


Figure 10.2 *The furnace excavated at Mancetter (photo: K.F. Hartley)*

Many working sites, particularly in the western provinces, have been recognised through archaeological excavation or post-excavation analysis of finds; for example, there are now more than 70 in France and more than 20 in Britain (Foy & Sennequier 1991; Sternini 1995; Nenna 2000; Foy & Nenna 2001). The nature of the surviving evidence for the sites is variable, but evidence for furnaces has frequently been recorded.

Most furnaces are known only from their ground plans and substructures and there is limited information about the details of construction, though pieces of the upper parts sometimes survive.* They are generally circular with a single flue, and small in size, measuring between 0.4 and 1.0m in diameter (Figure 10.2).⁹

The glass-working structures represented on first-century pottery lamps from Asseria in Croatia (Abramić 1959), Voghenza, near Ferrara in north-east Italy (Baldoni 1987), and Školarice-Križišče in Slovenia (Figure 10.3; Lazar 2004, 26–7, 56 no. 25, fig. 15) and on an unprovenanced first- or second-century terracotta group in the British Museum (Figure 10.4; Price 1988) add further detail to the archaeological evidence. The lamps show a low, domed superstructure with a sloping platform on one side at the top and the terracotta group shows a tall, tapering superstructure; both have with firing and melting chambers.

* Part of the clay and tile domed roof of a mid first-century furnace was found at La Manutention site 3 (also known as Subsistances) at Quai Saint-Vincent in Lyons (Foy & Nenna 2001, 48–9; Becker & Monin 2003, 299–302 figs 4–6), and the brick, tile and stone Byzantine furnace at Bet She'an (*Scythopolis*) in Israel had firing and melting chambers, although the superstructure was completely destroyed (Gorin-Rosen 2000, 59–60)

⁹ The diameters of furnaces 1 and 2 at La Manutention/Subsistances site 3 in Lyons were 0.9m and 0.6m (Foy & Nenna 2001, 48–9; Becker & Monin 2003, 299–302 figs 4–6), the four furnaces at Avenches were between 0.5m and 0.65m (Amrein 2001, 87), the late third-century furnace at Leicester was 0.6m and the second century furnace at Mancetter was initially 0.8m, later reduced by relining to 0.5 x 0.34m (Price 1998, 345).



Figure 10.3 *The furnace on the pottery lamp from Školarice-Križišče, Slovenia (photo: Tomaž Lauko)*

Comparatively little is known about the structure and layout of most urban workshops, though some, as at Avenches (Amrein 2001, 92–4), Besançon (Munier & Brkojewitsch 2003, 321–5 figs 2–4) and at Moorgate (Frere 1987, 463) and Regis House (MacMahon this volume, 62; Hall this volume, 132–3) in London, were sited in warehouses and other rectangular buildings. In some instances, as at Mancetter, a single circular furnace was relined several times, while Avenches and Lyons and other towns have produced evidence for groups of circular furnaces in close proximity, or, as in the first-century workshops at Besançon and Eigelstein in Cologne (Follmann-Schulz 1991, 35–6 fig. 4), for circular furnaces in association with rectangular structures (Figure 10.5). Workshops often appear to have functioned in rather confined spaces since new furnaces were constructed on top of earlier ones, though some may have operated more than one furnace at the same time.¹⁰ The workshop at Avenches has been reconstructed to show three furnaces operating simultaneously (Amrein 2001, 92–4 fig. 96), and but evidence of this kind is comparatively rare.

Uniquely, a great deal is known about the layout of the Byzantine glass workshop at Bet She'an as the building was destroyed in an earthquake in the sixth-early seventh century, sealing the structures and deposits inside. The workshop had a central room with a courtyard to the south and a store-room to the north. The single furnace was sited at the entrance to the central room and two adjacent heaps of ash and olive pits were used to anneal the vessels. Lumps of glass and groups of finished vessels were found in the central room, and the

¹⁰ This is observable in many urban glass workshops in the western provinces, as in furnaces 3 and 4 at Avenches (Amrein 2001, fig. 4), Besançon (Munier & Brkojewitsch 2003, figs 5–6), Eigelstein 14 and 35–37 in Cologne (Follmann-Schulz 1991, 35–6 fig. 4), and furnaces 1 and 2 at La Manutention/Substances no 3 at Lyons (Foy & Nenna 2001, 48 figs; Becker & Monin 2003), though not as yet in Britain.



Figure 10.4 *The furnace on the unprovenanced terracotta group (photo: British Museum)*

storeroom contained further groups of finished vessels, lumps of raw glass and cullet in pots and baskets or sacks, and materials for maintaining the furnace (Gorin-Rosen 2000, 59–60).

Although no information about leases or the conditions of operation for glass workshops has been found, the evidence of restricted working conditions mentioned above suggests that the available space was often limited. However, valuable information about a comparable craft activity has survived in papyrological records of short-term leases for potteries at Oxyrhynchus in Egypt (Cockle 1981). These include statements about provision of facilities, equipment and materials and the requirement that at the end of the term of the lease the pottery was to be returned to the lessor ‘free from ash and sherds’ (*i.e.* cleared and in a tidy state). Swan (1984, 50) has related this requirement to the systematic clearance of pottery sites in military *vici* in Britain on abandonment, where pits and ditches were filled, structures were dismantled and the area was levelled. Whether site clearance on exit was a general condition in leases for other craft and industrial activity is unknown, but such a requirement in leases for urban glass workshops might provide a context for the large deposits of glass waste and cullet buried in pits, as at Saintes (Amrein & Hochuli-Gysel 2000, 92–3), Guildhall Yard in London (Pérez-Sala Rodés 2001), and in the *canabae legionis* at Nijmegen (Isings 1980).

Location of workshops

Early glass workshops were set up away from the public and residential areas of towns and cities,¹¹ at the margins of the settlement and often close to rivers or main roads (Figure 10.6–8),

¹¹ As at Augst (Rütti 1991, 152–3), Avenches (Amrein 2001, 11–2), Besançon (Munier & Brkojewitsch 2003), Cologne (Fig. 11–7; Follmann-Schulz 1991, 35–6 fig. 2), London (Shepherd & Heyworth 1991, 14–5 figs 2, 4–5; Cleary 1996, 427), Lyons (Fig. 11.8; Foy & Nenna 2001, 42–3, 48–50; Becker & Monin 2003; Motte & Martin 2003) and elsewhere.

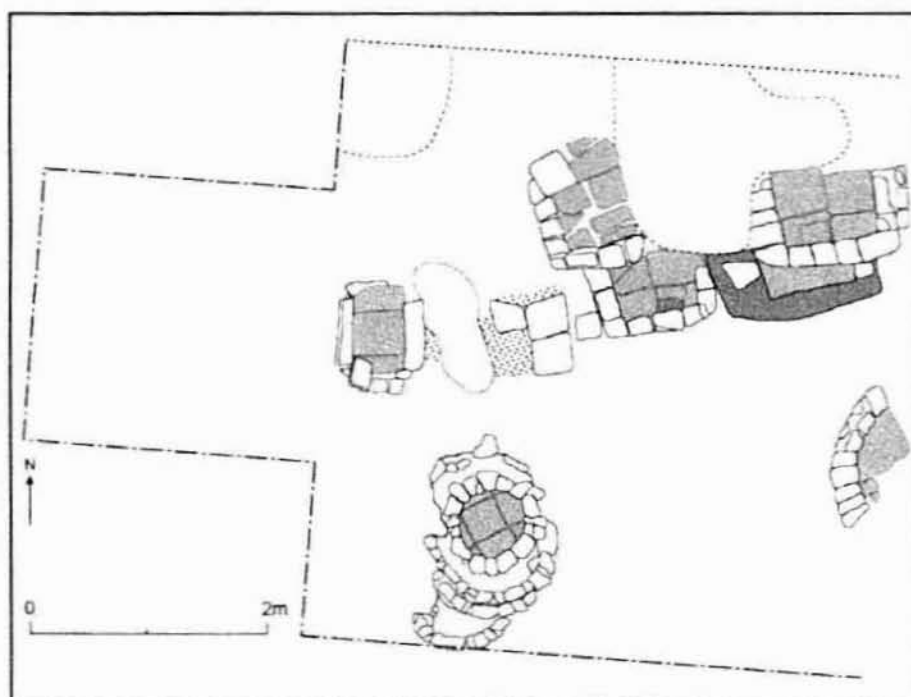


Figure 10.5 The glass-working site at Eigelstein 35/37, Cologne (after Follmann-Schulz 1991)

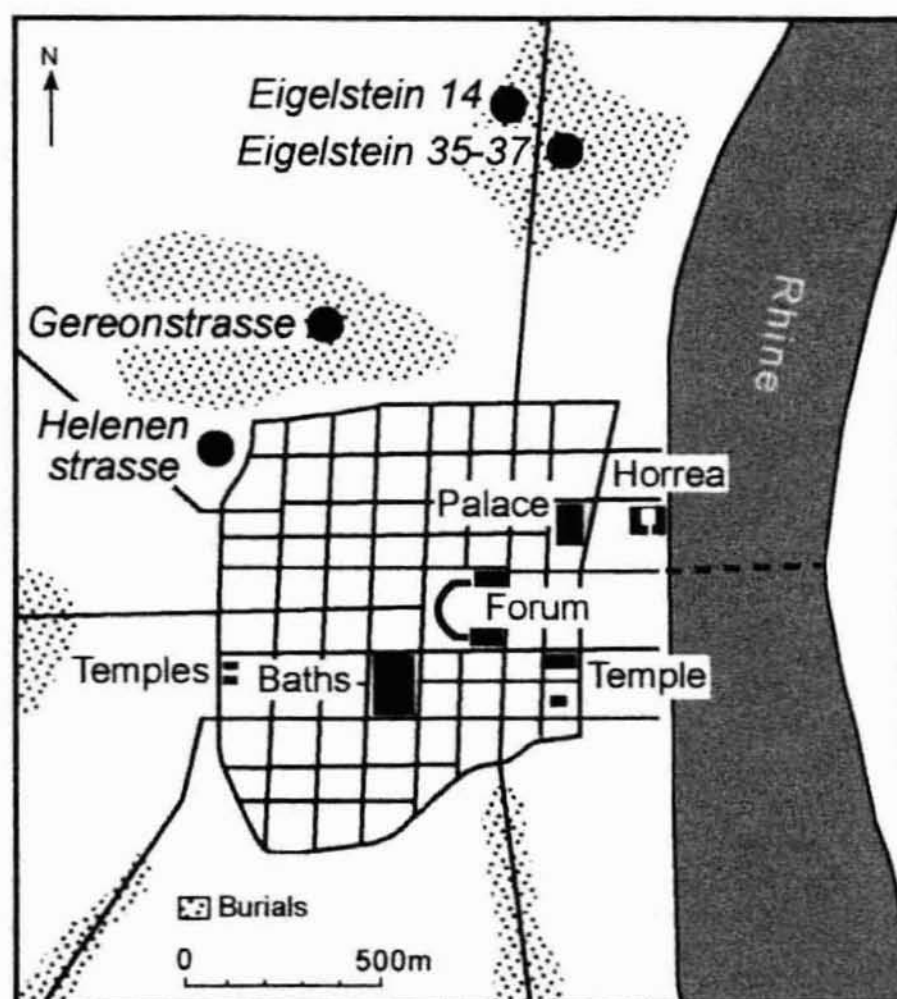


Figure 10.6 Glass-working sites at Cologne (after Follmann-Schulz 1991)

though in many cases the settled area subsequently expanded and engulfed them. Other craft processes, such as lime burning, metal smelting, pottery and tile making and tanning were also excluded from the central residential and public areas to minimise the risk of causing fires or damage to health through unpleasant fumes,¹² and in Britain and in other western provinces glass was often worked in close proximity to one or more of these activities.¹³

At later periods, glass workshops were often established within the walled areas of towns and cities, either close to the centre in public buildings or in areas which had gone out of residential use, or on the main thoroughfares. For example, the site of the late second- or early third-century furnace at La Vieille Monnaie in Lyons was originally a residential area (Foy & Nenna 2001, 52–3), the furnace at Leicester was constructed in the west colonnade of the city's market (Wacher 1978, pl. 30), and early fifth-century glassblowing debris has been found in the provincial forum at Tarragona in north-east Spain (Benet & Subias 1989, 343 nos 9.71–2, figs 188–9). These indications that urban life in the western provinces was breaking down are also recognisable elsewhere, as in Rome, where in the fifth century a glass furnace was built in the ruins of the *Crypta Balbi*, a public building in the *Campus Martius* (Sternini 1995, 183–4 fig. 258; Sagui 2000, 203–5).

The situation is rather different in the eastern provinces, where cities continued to function until the early seventh century, and glass production remained as part of the late Roman and Byzantine urban economy. For example, evidence for glass-working between the fourth or fifth century and the early seventh century has come from several cities in Israel. Production is attested in the area of the forum at Samaria-Sebaste (Crowfoot 1957, 404–5; Gorin-Rosen 2000, 58), in various parts of the city at Sepphoris (*Diocaesarea*) (Gorin-Rosen 2000, 57), and in a row of shops inside the north-east gate along the main street at Bet She'an (*Scythopolis*) (Mazor & Bar-Nathan 1998, 27–9; Gorin-Rosen 2000, 59–60). Similarly dated glass-working evidence has been recorded in Turkey, in the agora at Ephesus (pers. comm. Barbara Czurda-Ruth) and in the area of the synagogue and the baths complex at Sardis (von Saldern 1980, 95–7; Crawford 1990).

The glassworkers

In common with the majority of skilled artisans in the ancient world, little is known about the glassworkers as individuals. There are no detailed records of their activities and the names of

¹² Julian of Ascalon, probably writing in the sixth-early seventh century, said that workers in glass and iron should not carry out their business in the city, but if it was necessary, the workshops should be in remote and sparsely populated parts of the city, to prevent sickness and the destruction of property by fire (cited in Trowbridge 1930, 119).

¹³ At Moorgate in London a second-century glass workshop was associated with metal-, bone- and leather-working (Shepherd & Heyworth 1991, 14), at Deansway, Worcester, a second- or early third-century workshop was associated with iron-working (Price 1998, 346) and at Leicester a third- or fourth-century workshop may have been associated with cupellation of silver (Price & Cool, 1991, 24). Links between glass and pottery production are also frequent. An undated furnace with a crucible containing glass was found in an area of pottery kilns outside Water Newton in Cambridgeshire (Artis 1828, pl. XXV, 4–5), a second-century and later glass furnace (Figure 10.2) was excavated by Kay Hartley among the pottery kilns outside Mancetter (Price & Cool 1991, 24 fig. 3; Price 2002, 85 fig. 6), and a burnt floor and glass production waste in a pit were found among the late first- or early second-century pottery kilns at Sheepen, Colchester (Price 1998, 344). Similar links have also been noted in other provinces, as at Quai St-Vincent in Lyons (Foy & Nenna 2001, 49; Becker & Monin 2003; Motte & Martin 2003).

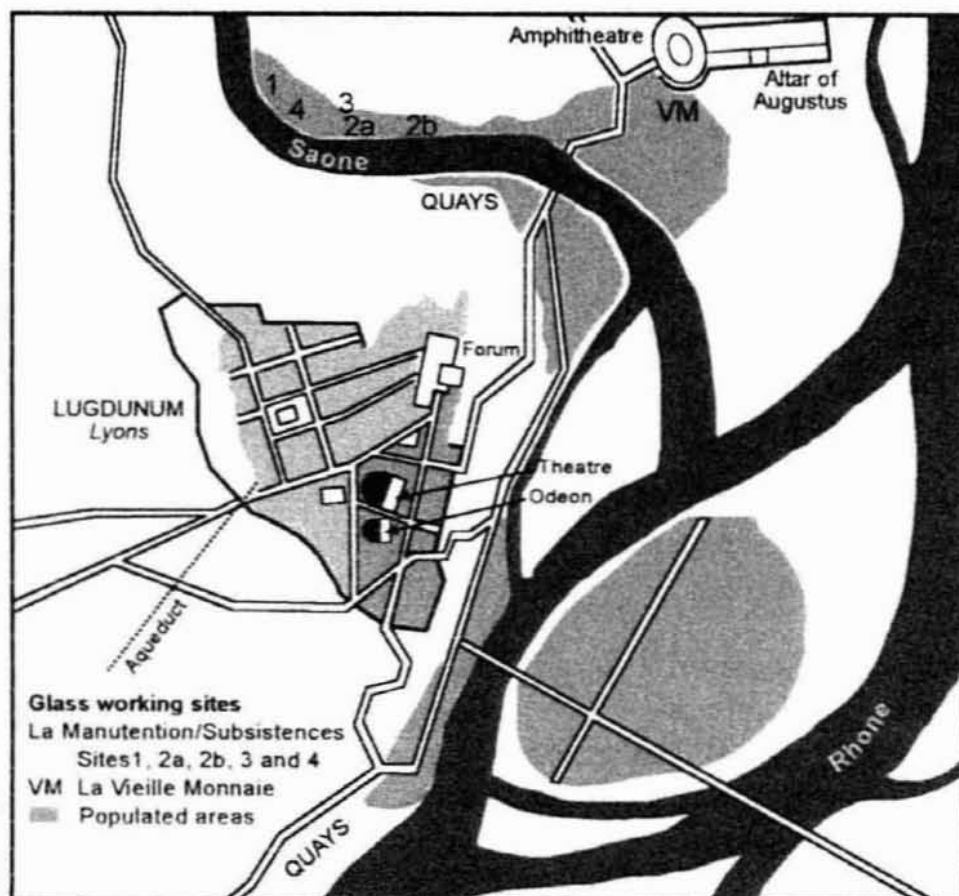


Figure 10.7 Glass-working sites at Lyons (after Foy & Nenna 2001)

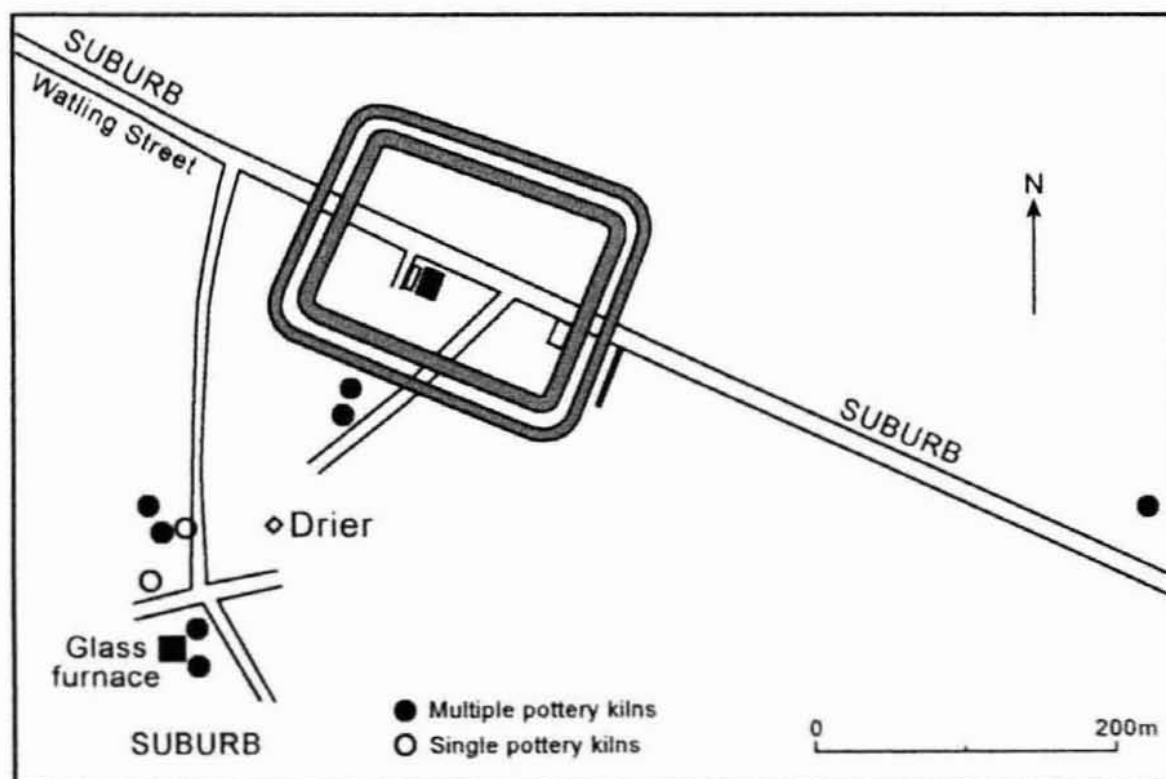


Figure 10.7 Glass-working and pottery production at Mancetter (after Burnham & Wachter 1990)

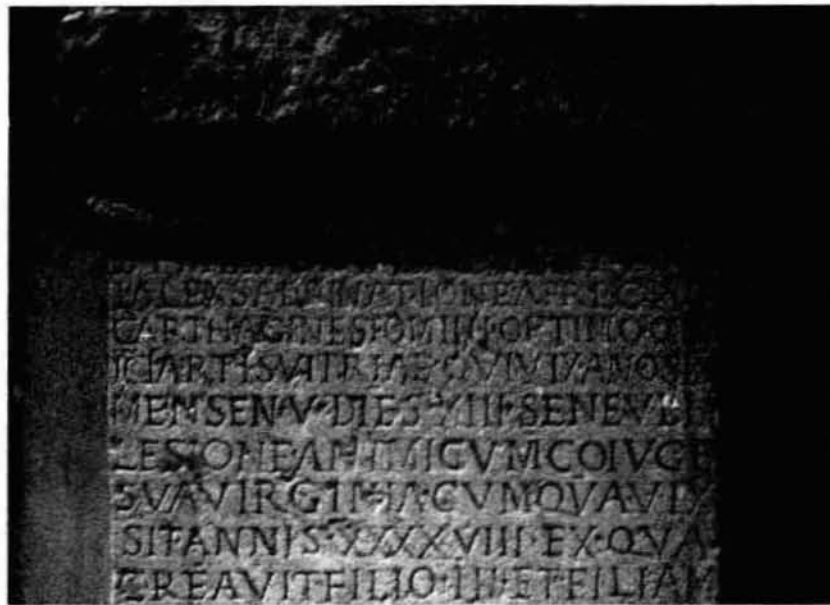


Figure 10.9 Funerary monument in Lyons commemorating Julius Alexander (photo: J. Price)

most of them have not survived. Numerous written accounts mention Roman glassworkers,¹⁴ but the names of these artisans were not recorded, presumably because they were not of interest to the writers or the readers.

The names of individual glassworkers generally occur either on their funerary monuments or on the glass vessels they made, though the pottery lamp from Asseria mentioned above bears the names of the two glassworkers (Abramić 1959). In general, funerary monuments provided few details about the workers other than their name, craft and age,¹⁵ though their origins and affiliations were occasionally recorded. For example, Julius Alexander, described as *opifex arti vitriae* (master in the art of glass), who died aged 75 years, five months and 13 days, and is commemorated on a third-century tombstone found in Lyons (Figure 10.9), was born in Africa and a citizen of Carthage (Foy & Sennequier 1989, 61–2 no. 8).

The information found on the glass vessels, many of which were mould-blown, is also largely confined to the name, though a place of origin is sometimes included. On early imperial mould-blown decorated tablewares the name is found within the design on the body (Figure 10.10),¹⁶ while on mould-blown prismatic or cylindrical corrugated bottles the name is

¹⁴ Such as Strabo, who wrote ‘...I heard in Alexandria from the glass workers...’ (*Geography* 16.2.25), Seneca, who noted the glassblower ‘...who by his breath alone fashions glass into a thousand shapes...’ (*Epistulae Morales* 14.90.29), and Petronius and Pliny who wrote about a glassworker who showed a glass vessel that did not break to the emperor Tiberius (*Satyricon* 51; *Natural History* 36.195).

¹⁵ For example, brief epitaphs in Latin or Greek for glassworkers are known on tombstones in Cherchel, Salona, Sparta, Athens, Tyre and elsewhere (listed in Trowbridge 1930, 114–28; Foy & Nenna 2001, 67).

¹⁶ Names on mould-blown tablewares, such as Aristeas (Calvi 1965), Aristeas the Cypriot (Constable-Maxwell 1979, 157–60, lot no. 280), Ennion (Figure 10.10; Harden 1935; Lehrer 1979; Price 1991; Barag 1996), Jason, Meges and Neikais (Harden 1935; Stern 1995), were generally in Greek characters. A few mould-blown tablewares have Latin names, such as C Caesius Bugaddus on African-head beakers (Price 1974).

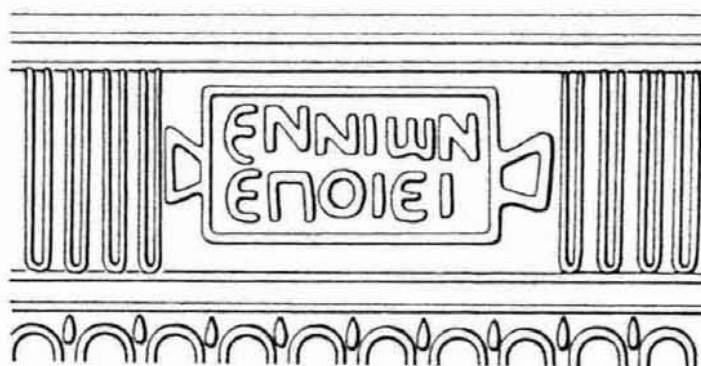


Figure 10.10 ENNION in Greek characters on an unprovenanced mould-blown cup in Newark Museum, New Jersey (after Lehrer 1979)

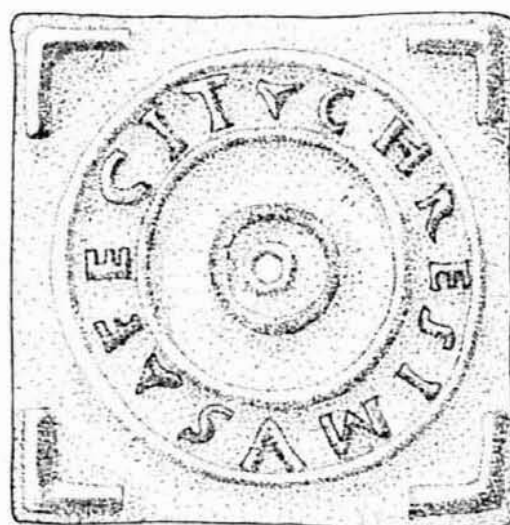


Figure 10.11 CHRESIMUS.FECIT. in Latin characters on the base of a rectangular bottle from Usk, South Wales.

included in the design on the base (Figure 10.11).¹⁷ Names are much less common on free-blown vessels, but these were sometimes impressed into the end of the handles of drinking cups (Figure 10.12).¹⁸

¹⁷ Most names on the bases of the mould-blown bottles produced in the western provinces were Latin or latinised. Names such as Sentia Secunda of Aquileia (Harden 1969, 49, 73 pl. IVB), Gn Asinius Martialis (Price 1981, 353–4 fig. 113.47; RIB 2.2, no. 2419.106–7), P Gessius Ampliatus (Scatozza-Horicht 1986, 76, fig. 12), Titianus Hyacinthus (Whitehouse 2003) or Chresimus (Figure 10.11; Price 1995, 186 no. 124, fig. 48, pl. xv; Hanel 1995, 246, 661 E147, taf. 155) are found on first- and second-century prismatic bottles, and Felix (Isings 1957, 107; Painter 1968, 62 no. 79), Frontinus (Chassaing 1961; Sennequier 1985, 169–82) and other names occur on second- to fourth-century cylindrical corrugated bottles. Names in Greek characters, such as Paulinos of Antioch, Magnos, Theodoros, Alexandros or Zosimos, have also been recorded on third- to fifth-century prismatic bottles, especially in the eastern Mediterranean (Barag 1987, 109–11; Jacobson 1992; Sternini 1994; Tek 2003)

¹⁸ Names such as Ariston, Artas (Figure 10.12), Neikon and Philippos, sometimes in both Greek and Latin characters and sometimes giving Sidon as their place of origin, were impressed on the wings of folded handles of first-century cups. Many have been found in Rome (Fremersdorf 1938; Sagui *et al.* 1996, 218 fig. 3; Sagui 1998, 22–3 fig. 21) and elsewhere in the western provinces, though some are from



Figure 10.12 ARTAS SIDON in Latin and Greek characters on the folded handle of a cup from Rome (after Fremersdorf 1938)

There is little evidence to determine whether glass workers worked full time at their craft or combined seasonal glass-working with other activities, but there are some indications that craftsmen moved from place to place to produce glass for urban populations. Julius Alexsander, who died (and presumably worked) in Lyons was a native of Africa and a citizen of Carthage, and similar movements of craft skills in the early imperial period are implied by the addition of 'the Cypriot' or 'of Sidon' to the names on mould-blown and free-blown tablewares.

Regional patterns of production of glass vessels are recognisable from the middle of the first century onwards, and it is occasionally possible to identify a glass worker operating within a limited geographical area. For example, the name Amaranthus is found on several forms of first-century tablewares and containers in Burgundy and elsewhere in central France (Sennequier 1986; Cabart 2003, 162).

Some of the activities and organisations of urban glassworkers are recorded in legal documents, or in epigraphic and papyrological sources. In the early first century, glassworkers in Egypt were listed among the traders and artisans in the Tebtunis papyri (cited in Trowbridge 1930, 51 fn. 14), in the third century glassworkers were taxed by Alexander Severus (*SHA Aurelius Lampridius: Alexander Severus* 24.5) and glass from Egypt was taxed by Aurelian (*SHA Flavius Vopiscus: Divus Aurelianus* 45.1), while under Constantine in the early fourth century *vitrearii* (glassworkers) and *diatretarii* (cutters) were exempted from taxes to enable them to 'become more skilled and to train their sons' (*Codex Theodosianus* 13.4.2). Papyri from Oxyrhynchus in Egypt refer to a guild of glass workers in the city in the early fourth century (Bowman *et al.* 1977, 146 no. 3265; Coles *et al.* 1987, 113–5 no. 3742) and a guild of *specularii* (window glassmakers) is attested in Rome (CIL vi.2206). Further epigraphic references to *specularii* have been found in Rome, including a third- or fourth-century funerary inscription in the catacomb of Domitilla commemorating Sabinius Santias which includes a sketch of a window with nine panes (CIL vi.33911; Sternini 1995, 183 fig. 257).

Supplying glass in the city

After the middle of the first century, much of the glass used in towns and cities may not have travelled far from the workshop to the consumer, but some vessels, particularly pieces

the east Mediterranean, as at Corinth (Davidson 1952, 103 no. 650 fig. 10) and Mytilene (Price & Cottam 2000, 59 fig. 2.5).

involving exceptionally high standards of craftsmanship in their manufacture and decoration, are likely to have been produced in specialist workshops and distributed over longer distances, by water and on land. Vessels have been found in Mediterranean shipwrecks and port deposits,¹⁹ and the movement of glass vessels by pack-animals is also attested in the Babylonian Talmud (cited in Weinberg 1988, 25 fn. 2).

Little is known about the cost of glass before the fourth century, the principal source of this information being the Edict of Maximum Prices, issued by Diocletian in AD 301. Fragments of the section on the prices for glass found in Aphrodisias between 1970 and 1972 refer to two different kinds of glass, Alexandrian and Judaeon, and describe two categories of each, raw glass and undecorated vessels, and two categories of window glass, all of which were priced by weight. The inscription was studied by Barag (1987, 113–6) who argued that the names for the kinds of glass did not indicate that they were produced in Alexandria or Judaea. He interpreted these names as traditional trade-names for glass of different qualities, Judaeon being the bluish green and greenish common glass and Alexandrian the colourless, high-quality glass. More recently, Stern (1999, 460–6) has used the Edict of Maximum Prices to calculate that the cost of a glass vessel was between 10 and 20 times more than the cost of a pottery vessel of equivalent capacity, and that the cost of one or two vessels of average size of Judaeon glass, or one of Alexandrian glass, was equivalent to daily wage of an unskilled labourer. She has also pointed out that the listed maximum prices for glass appeared to be very low and that the price differential between the raw glass and the finished vessels, allowing for the loss of up to 40–45% of the glass during the production processes,²⁰ would have made it difficult for glassblowers to earn a living and may have driven utilitarian vessel glass out of the market.

Retail outlets for glass in towns and cities

Information about the arrangements for retailing glass is sparse. Generally, it is not known whether glass was sold from shops, or stalls in the town markets, or from the workshops, or whether the glassworkers doubled as retailers or supplied glass to order, or whether retail outlets specialised in glass or stocked glass with other goods. In discussing glass vessels as merchandise, there is a distinction between tablewares which were produced for sale in their own right and containers for other products. The latter group – bottles, flasks jars, pots and unguent bottles – were intended to hold a wide variety of liquid and semi-liquid preparations, and were presumably made for the use of other trades and professions, such as food suppliers, perfume and unguent makers, or pharmacists and doctors.

Links between glassworkers and frankincense dealers are suggested in the epigraphic reference to ‘the quarter of the glassworkers, also known as the quarter of the incense dealers’ in Puteoli (Dessau 1892, 269 no. 1224b), and there is an indication of connections between glass vessels and perfume production at Pompeii. During the excavation of the large garden

¹⁹ For example off the coast of south-eastern France, the cargo in an Augustan wreck at La Tradelière included 200–300 ribbed and plain sagged glass bowls stacked in piles in boxes and separated by layers of vegetable matter (Feugère & Leyge 1989; Foy & Nenna 2001, 105), and the cargo of a late second-century wreck at Embiez-Ouest included colourless drinking vessels packed in groups of five (Foy & Nenna 2001, 110–1). First-century port deposits are known from Pisa in Italy (Stiaffini 2000) and Narbonne (Feugère 1992) and a late second- to third-century deposit has been found in London (Shepherd 1986).

²⁰ Based on her practical experience as a glassworker.

attached to house II.viii.6, thought to have been a commercial flower garden producing flowers for the perfume industry, an exceptional number of fragments of small glass unguent bottles and some almost complete specimens were found, and a large number of similar unguent bottles came from a room within the house (Jashemski 1979, 407, 410, pl. 58 fig. 7).

Glass containers also appear to have been used for medical preparations from the early empire onwards. Small glass vessels have sometimes been found in the tombs of doctors (*e.g.* Künzl 1982, figs 66, 70–2, 74, 88), and textual references also refer to the use of glass containers. For example, Scribonius Largus, writing in the Claudian period,²¹ specified glass vessels as suitable for containing liquid, honey-like, dry gummy and waxy medical preparations (see Taborelli 1996 for discussion of this text).

Shops selling glass

The interpretation of the precise functions of retail outlets in Roman towns and cities is usually problematic as diagnostic evidence is only likely to survive when commercial activity came to an abrupt halt as a result of an unforeseen disaster. Nonetheless, a few structures have been interpreted as storerooms or shops selling glass in the early empire and in the fourth and later centuries.

The earliest was found in the *colonia* at Cosa, about 100km north of Rome, where between AD 40 and 45, the north-west wall of the forum-basilica collapsed on an adjacent building, demolishing several rooms at the rear of the annexe to the *atrium publicum*. The rooms in this building had wide doorways facing the forum or the surrounding streets and were probably shops rented by the town to tradesmen (Grose 1974; Brown *et al.* 1993, 135–7, 241). The annexe housed two *tabernae* with several rooms, and a back room (22,II) destroyed by the collapse of the wall produced two coins, more than 200 Arretine, thin-walled and coarse ware pottery vessels, 12 amphorae, more than 40 pottery lamps, 76 glass vessels, mostly tablewares, and a range of other objects. The pottery and glass were chronologically contemporary, most pieces being well-preserved with little signs of use, indicating that they were probably assembled only shortly before the room was destroyed, and the deposit has been interpreted as stock in the storeroom of a shop (Grose 1974).

Soon after this time, a building on the main street in *insula* XIX in the *colonia* at Colchester was destroyed by fire and a deposit containing hundreds of South Gaulish samian vessels, some colour-coated pottery and a large quantity of glass, mostly completely melted, was sealed by the collapse of the walls (Hull 1958, 153–4, no. 127; Harden 1958; see also Mac Mahon this volume, 64). This was identified as a store or shop, in which the pottery vessels appeared to have been stacked in piles on the floor or a low shelf with the glass vessels above them on a higher shelf. As the glass had dripped over the pottery, fused together, or melted into lumps during the fire, the vessel forms cannot be discussed in detail but they appear to have been mainly tablewares and probably imported from Italy or southern Gaul. The precise date of destruction of the Colchester shop is uncertain; Millett (1987, 102–6) has argued that on the evidence of the stamps on the samian this could have been around AD 50–55, while Crummy (1997, 82) favours AD 60/61, the date of the Boudican destruction of the *colonia*. It is noteworthy that the Cosa and Colchester deposits have produced glass tablewares as stock in association with pottery tablewares. Both these retail outlets functioned at a time when glass

²¹ Sconocchia, S. 1983. *Scribonii Largi, Compositiones*. Leipzig, Teubner

vessels were probably not being locally produced, and they appear to have stocked categories of goods likely to appeal to the same urban markets.

Glass vessels may also have been associated with pottery in some later retail outlets in civil settlements in Britain, though this is less certain as deposits sealed within buildings have not been found. For example, a building on the main road in the *vicus* at Castleford, West Yorkshire, has been identified as a pottery shop (Dickinson & Hartley 2000, 36–55; Rush 2000, 149, 158 fig. 82; Hartley, 2000). It was destroyed by fire around AD 140–50 and approximately 600 burnt Central Gaulish samian vessels, plus a large quantity of other burnt pottery vessels, principally *mortaria* and Black Burnished wares, were subsequently used as levelling material in the surrounding area. Considerable quantities of glass fragments distorted by heat were found in association with the pottery, suggesting that the shop may also have dealt in glass vessels (Cool 1998a, 8; 1998b, 355, 360).

By contrast, the Flavian and later deposits interpreted as shops or storerooms in the Mediterranean world appear to have contained only glass vessels and objects, though there is some uncertainty about this as information about other materials in the deposits is not always available. The *taberna* on the north-east side of the *decumanus maximus* to the west of *cardo* IV at Herculaneum destroyed in the eruption of Vesuvius in AD 79 contained a wooden crate with 46 or 47 glass vessels packed in straw. Of these, 35 were tablewares and 11 or 12 were probably containers (de Franciscis 1963; Scatozza Hörcht 1986, cat. nos 2341–2376). The commercial context of the find is uncertain as finds on the floor or shelves of the *taberna* have not been recorded, and the deposit raises some questions about retailing glass vessels. It is noteworthy that several forms of apparently empty containers were packed in the same consignment as tableware vessels, and that single examples of some forms were present as well as sets of nearly identical vessels. The name on the base of the square bottle, P Gessius Ampliatus, has been noted elsewhere in Campania (see fn. 16), and much of the glass was probably produced in local workshops, although there is no evidence that P Gessius Ampliatus made the other vessels in the packing case (*contra* Scatozza Hörcht 1986, 22; 1991, 77).

Further instances of glass vessels packed in cases have been recorded in Karanis, a town in the Fayoum in Egypt (Wainwright 1924; Harden 1936). Seventy pieces of fourth-century glass, almost all in perfect condition, were found in ten elaborately decorated wooden boxes some of which were repaired. The position and context of the find were not recorded, but the size of the find, the presence of locks on the boxes, and the straw packing in one box caused Wainwright (1924) to interpret the deposit as the stock of a dealer, perhaps a glass merchant, rather than as the contents of a private house. Harden (1936, 34–8), however, pointed out that more than half of the complete glass vessels found at Karanis came from comparable groups or hoards. He listed 13 deposits found in large pottery vessels, wooden boxes, palm-leaf baskets, niches in walls, or pits in the floors, sometimes with other household objects, and argued that they contained tablewares used by the inhabitants of the town in the fourth century. It is therefore necessary to view this deposit with some caution, since storing glass in containers was apparently a late Roman domestic or ritual, rather than commercial, practice at Karanis.

At Sardis, a row of more than thirty shops is known at the back of the south colonnade of a large public building complex containing the baths, gymnasium and synagogue (von Saldern 1980, 35–97; Crawford 1990). Most of the shops produced some glass, and two (E 12–13) contained exceptional quantities of vessel and window glass fragments. These shops appear to have been used either to store stock or broken glass for recycling, or, more probably, to sell



Figure 10.13 Glass vessels in a *taberna*; from a catacomb at Sousse, Tunisia (after Foy & Nenna 2001)

ordinary and locally produced glass vessels, including goblets, bottles, flasks and lamps and window panes. The shops are not closely dated, but they appear to have functioned from around AD 400 until they were destroyed by fire in the early seventh century, and the range of glass forms is broadly comparable with the Bet She'an finds (see below).

The position of the sixth- or early seventh-century glass workshop at Bet She'an among other shops on a main thoroughfare and the finds in it suggest that it may also have functioned as a retail outlet, though we must wait for the final report for a definitive interpretation. Vessels of similar form were grouped together and neatly stacked in piles on shelves, in niches in the walls and in baskets on the floor in the central room and the storeroom. The range of forms was limited to three kinds of everyday table and household wares (drinking vessels, flasks and jugs), plus bowl-shaped lamps with stems and rectangular and circular window panes, and these were probably supplied to customers within the city, since similar forms have been found in churches and tombs nearby (Gorin-Rosen 2000, 59–60).

Glass use in urban contexts

In examining the evidence for working and supplying glass in towns and cities, some uses of glass tablewares and containers have also been mentioned, as has the relationship of glass containers to other urban crafts such as food preparation, medicine and perfume making. Archaeology and writings are the principal sources of information for considering the functions of glass vessels, but iconographic evidence in mosaics, wall decoration and funerary monuments are also valuable for showing how both tablewares and containers were used and treated in everyday life.

Glass was sometimes included in tavern scenes, as in a wall painting from a catacomb at Sousse in Tunisia (Figure 10.13) where drinking vessels were arrayed on the counter and shelves of a *taberna* (Foy & Nenna 2001, 185, fig.). Similar vessels occurred in other drinking

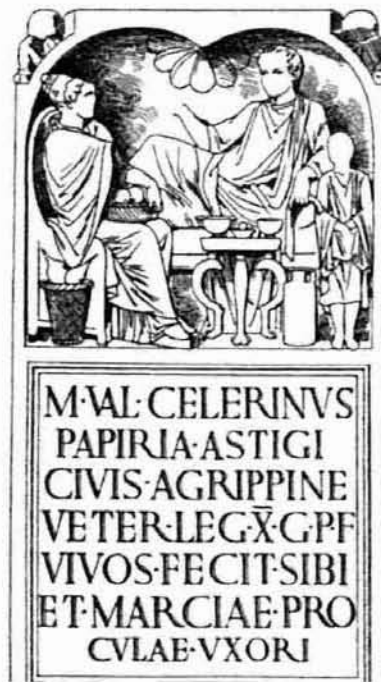


Figure 10.14 Tombstone of M. Valerius Celerinus in Cologne, showing a bottle on the floor beside the table (after Kisa 1908)

and dining scenes, as did glass containers. In the dining scenes on some funerary monuments in the Rhineland (Figure 10.14), prismatic and cylindrical bottles were placed on the floor close to dining tables.²² The Neumagen bottles were enclosed in woven, presumably wickerwork, or solid, presumably wooden, cases, and bottles with similar casing are shown on a mosaic from El Djem and a in wall-painting from Carthage (Foy & Nenna 2001, 114, figs), suggesting that protection of this kind may have been common for household bottles.²³ It is also apparent that other glass containers were protected in daily use, although the casings have survived only in dry conditions.²⁴ Glass tablewares were also carefully looked after within dwellings, as in the cupboards at Pompeii and Herculaneum, and the various containers, wall niches and pits at Karanis, and additional packaging was employed to safeguard personal items on journeys. For the most part the journeys were completed and the packaging has not survived, but a neatly wrapped and bulky package of palm fibres tied with a palm fibre cord

²² As at Neumagen on the River Moselle (von Massow 1932, 197–8 nos 260, 261a–b, pl. 50) and at Cologne, on the tombstone of Marcus Valerius Celerinus, (Figure 10.14) a veteran of the Tenth legion who was a native of Astigi in Spain and a citizen of Cologne (Kisa 1908, 89, 237, 324, fig. 14). At Simpelfeld, the household effects in the scenes carved inside the sarcophagus included cylindrical and square bottles standing on a low bench (Holwerda 1933; Liversidge 1955, 65–6, pls 68–9).

²³ Wooden carrying cases containing bottles are known at Pompeii (Kisa 1908, 89 fig. 15), and corded and basketwork impressions, perhaps from casing, have been noted in the melted surface of a cylindrical bottle from Rocester in Staffordshire (Cool 1996, 108, 117 no. 36 fig. 41.21, pls 13–14). In addition, many bottles have vertical scratches on their sides, presumably from being lifted in and out of closely fitting cases.

²⁴ In Egypt, the body and neck of flasks and unguent bottles were often protected by fixed papyrus or palm-frond wrappings (Edgar 1905, 54 nos 32.655–62, pl. VIII; Foy & Nenna 2001, 115 no. 135), and it is likely that, using different wrapping materials, this practice also occurred in other parts of the Roman world.

protecting three colourless plates left in the Cave of the Letters in the Judaean Desert in Israel in the second quarter of the second century (Yadin 1963, 41, 101, 105–10, figs 39–40 pls 29.66/1, pl. 30.66/2–4) shows the care that was taken of treasured household possessions.

As already explained, vessel glass accounted for only part of the glass consumed in cities and towns. Architectural schemes also required large quantities of glass for windows, and for the decoration on floors, walls and vaults. Window glass was used in buildings for keeping heat in, letting light into the building and excluding draughts, and in certain situations it may have combined protection from the elements with providing a view for the occupants of buildings (pers. comm. Chris Martins). By contrast, the glass tesserae in wall and vault mosaics were largely decorative though they must also have been valuable for reflecting light within the buildings.

Glazed windows were fitted in high-status private residences in many parts of the Roman world but they occurred principally in public buildings, and especially in bath-houses, from the early first century onwards (Whitehouse 2001). Wall and vault mosaics using glass tesserae also appeared in baths and palatial buildings in the first century AD and their use increased over time (Sear 1976, 234–9; Sear 1977, especially 22–30, 41–3).

The bath-houses at Pompeii and Herculaneum provide much information about first-century glazing patterns. In particular, it is noteworthy that some circular roof windows (*oculi*) were glazed (Allen 2002, 106–8 fig. 8.7) and that some glazed windows had removable frames or were double-glazed (Whitehouse 2001, 35). Less is known in detail about most of the glazing schemes in later civic baths, though they undoubtedly became more complex as larger, more monumental, baths were constructed in the second and later centuries. A papyrus found at Oxyrhynchus indicates that 6000lb of glass were required for the construction of the public baths and gymnasium there in the early fourth AD (Bowman *et al.* 1977, 146 no. 3265) but whether this was to make the windows, or the glass tesserae for wall and vault mosaics, or both, is uncertain.

The numerous imperial bath-houses in Rome and other cities must have consumed very great quantities of glass for their construction and embellishment. A detailed study of the Baths of Caracalla which were built in Rome in the early third century has calculated the quantities of materials, including glass tesserae and window glass, used in this very large imperial project (DeLaine 1997). Glass tesserae²⁵ decorated more than 16,900 square metres of the interior walls and vaults and parts of the exterior of the central block of the baths; approximately 254 million tesserae were required (at 15,000 to the square metre) (DeLaine 1997, 70, 75, 181, fig. 45),²⁶ and they weighed approximately 380 tonnes.²⁷ In addition, it is estimated that glazing the windows would have required at least 3,400 square metres of glass (*ibid.*, 318) weighing approximately 50 tonnes.²⁸

²⁵ In shades of lilac, blue, turquoise, green, yellow, ochre and red and clear glass with gold or silver leaf backing (DeLaine 1997, 70)

²⁶ Requiring the services of 220 wall mosaicists plus 70 assistants, and 60 men to cut the glass tesserae (DeLaine 1997, 188)

²⁷ Taking the average depth of the tesserae as 0.009m (DeLaine 1997, 181) and the weight of glass per m³ as 2.5 tonnes (*ibid.*, 218 fn. 43).

²⁸ Taking the average thickness of the window glass as 0.006m and the weight of the glass as 2.5 tonnes per m³ (DeLaine 1997, 218 fn. 43)

Although only a minor part of the range of processes involved in constructing in this complex of buildings, the production, supply, working, shaping and fitting of around 430 tonnes of glass was an immense undertaking, requiring the services of large number of skilled artisans in addition to the 350 individuals estimated to have been working with the glass mosaic tesserae. This striking illustration of the very large quantity of glass needed within a short period for a single imperial public building²⁹ raises questions about the supply of glass, the organisation of production, the siting of glass workshops and the size of the glass-working community in Rome and elsewhere. It is also a reminder of the yawning gap that exists between the reality of the processes of Roman glass-working and our current knowledge of them from the surviving evidence.

Conclusions

Although comparatively little is known in detail, it is apparent that the working of glass was widespread in the Roman world, and that workshops may have been set up in the vicinity of very many cities and towns. The requirements of the populations of very large cities, such as Rome, must have been served by several glass workshops operating simultaneously. By contrast, the glass produced for smaller towns, such as Mancetter, Leicester or Wroxeter, is more likely to have been made by travelling glassworkers who visited from time to time and worked for a brief period in each place. It is seldom possible to identify the products of an individual workshop, but for everyday vessel glass and large, heavy items such as sheets of glass for windows and mosaics, there would have been distinct advantages in moving the human skills to the intended markets, rather than the finished products. While patterns of glass use varied considerably in different parts of the Roman world, there is little doubt that glass was available to many levels of urban society, and that it was accepted as a relatively useful and inexpensive addition to the amenities and comforts of daily life.

Acknowledgements

In writing this paper I have received assistance from many colleagues and friends, including Heidi Amrein, Don Bailey, Hilary Cool, Barbara Czurda-Ruth, Anna Barbara Follmann-Schulz, Danielle Foy, Yael Gorin-Rosen, Dai Grose, Irena Lazar, Ardle Mac Mahon, Chris Martins, Marie-Dominique Nenna, Marianne Stern and Hugh Willmott, and I would like to thank all of them for information, discussing points with me and answering questions.

I am also very grateful to Yvonne Beadnell and Jeff Veitch in the Department of Archaeology, University of Durham for producing the drawings and photographs.

Bibliography

- Abramić, M. 1959. 'Eine römische lampe mit darstellung des glasblasens', *Bonner Jahrbücher* 159: 149–51
- Allen, D. 2002 'Roman window glass', in Aldhouse-Green, M. & Webster, P. (eds) *Artefacts and Archaeology*. University of Wales Press, Cardiff; 102–11

²⁹ The quantity, around 430 tonnes, is almost three times the calculated output of the seventeen primary furnaces at Bet Eliezer, near Caesarea in Israel (Gorin-Rosen 1993, 42–3)

- Amrein, H. 2001. *L'atelier de verriers d'Avenches. L'artisanat du verre au milieu du I^{er} siècle apr. J.-C.* Aventicum XI (Cahiers d'archéologie Romande no 87), Lausanne.
- Amrein, H. & Hochuli-Gysel, A. 2000. 'Le soufflage du verre: attestations de la technique à Avenches (Suisse) et à Saintes (France) au I^{er} siècle apr. J.-C.', *Annales du 14^e Congrès de l'Association Internationale pour l'Histoire du Verre* (Venise-Milan 1998), Lochem: 89–94
- Artis, E.T. 1828. *The Durobrivae of Antoninius identified and illustrated in a series of plates, exhibiting the remains of that Roman station, in the vicinity of Castor, Northamptonshire*. Privately printed, London.
- Baldoni, D. 1987. 'Una lucerna romana con raffigurazione di officina vetraria: alcune considerazioni sulla lavorazione del vetro soffiato nell'antichità', *JGS* 29: 22–9
- Barag, D. 1987. 'Recent important epigraphic discoveries related to the history of glassmaking in the Roman period', *Annales du 10^e Congrès de l'Association Internationale pour l'Histoire du Verre* (Madrid-Segovie 1985): 109–16
- Barag, D. 1996. 'Phoenicia and mould-blowing in the early Roman period', *Annales du 13^e Congrès de l'Association Internationale pour l'Histoire du Verre* (Pays Bas – 1995): 77–92
- Becker, C. & Monin, M. 2003. 'Fours de verriers antiques des Substances, Lyon', in Foy, D. & Nenna, M.-D. (eds) *Échanges et commerce du verre dans le monde antique*. Actes du colloque de l'AFAV, Aix-en-Provence et Marseille 2001. Monographies Instrumentum 24. Montagnac, Monique Mergoil: 297–302
- Benet i Arque, C. & Subias i Pascual, E. 1989. 'Rebuigs i restes de fabricació', in TED'A, *Un abocador del segle V D.C. en el Fòrum Provincial de Tàrraco*. Memòries d'Excavació 2. Tarragona, Taller Escuela d'Arqueologia: 343
- Bowman, A.K., Haslam, M.W., Stephens, S.A. & West, M.L. 1977. *The Oxyrhynchus Papyri, volume 45*. British Academy, London.
- Brown F.E., Richardson, E.H. & Richardson, L. 1993. *Cosa III: The Buildings of the Forum*. Memories of the American Academy in Rome 37, Pennsylvania State University Press, Pennsylvania.
- Burnham, B.C. & Wachter, J. 1990. *The 'small towns' of Roman Britain*. Batsford, London
- Cabart, H. 2003. 'Productions et importations de verreries romaines dans l'Est de la France', in Foy, D. & Nenna, M.-D. (eds) *Échanges et commerce du verre dans le monde antique*. Actes du colloque de l'AFAV, Aix-en-Provence et Marseille 2001, Monographies Instrumentum 24, Montagnac, Monique Mergoil: 161–76
- Calvi, M.C. 1965. 'La coppa vitrea di Aristeas nella collezione Strada', *JGS* 7: 9–16
- Chassaing, M. 1961. 'Les barillets frontiniens', *Revue Archéologique du Centre et du Centre-Est* 12: 7–33; 89–104
- Cleary, S.E. 1996. 'Roman Britain in 1995: Sites explored', *Britannia* 27: 405–38
- Cockle, H. 1981. 'Pottery manufacture in Roman Egypt; a new papyrus', *JRS* 71: 87–97
- Coles, R.A., Maehler, H. & Parsons, P.J. 1987. *The Oxyrhynchus Papyri Vol 54*. British Academy, London.
- Constable-Maxwell. 1979. *Sale Catalogue of the Constable-Maxwell Collection of Ancient Glass (London, 5th-15th June 1979)*. Sotheby Parke Burnett, London.
- Cool, H.E.M. 1996. 'The Roman vessel glass', in Cleary, S.E. & Ferris, I.M. (eds) 'Excavations at the New Cemetery, Rocester, Stafordshire, 1985–1987', *SAHST* 35: 106–121
- Cool, H.E.M. 1998a. 'Introduction', in Cool, H.E.M. & Philo, C. (eds) *Roman Castleford Volume 1: The Small Finds*. Yorkshire Archaeology 4. West Yorkshire Archaeology Service, Wakefield: 1–10
- Cool, H.E.M. 1998b. 'Life in Roman Castleford', in Cool, H.E.M. & Philo, C. (eds) *Roman Castleford Volume 1: The Small Finds*. Yorkshire Archaeology 4. West Yorkshire Archaeology Service, Wakefield: 355–73
- Cool, H.E.M., Jackson, C.M. & Monaghan, J. 1999. 'Glass-making and the Sixth Legion at York', *Britannia* 30: 147–61
- Cool, H.E.M. & Price, J. 1995. *Roman vessel glass from excavations in Colchester, 1971–85*. Colchester Archaeological Report no 8, Colchester.

- Crawford, J.S. 1990. *The Byzantine Shops at Sardis*. Archaeological Exploration of Sardis Monograph no 9, Harvard University Press, Cambridge, MA.
- Crowfoot, G.M. 1957. 'The glass', in Crowfoot, J.W., Crowfoot, G.M. & Kenyon, K.M. (eds) *Samaria-Sebaste III: The objects from Samaria*. Palestine Exploration Fund, London: 403–22
- Crummy, P. 1997. *City of victory: the story of Colchester – Britain's first Roman town*. Colchester Archaeological Trust, Colchester.
- Davidson, G.R. 1952. *Corinth XII: the Minor Objects*. American School of Classical Studies at Athens, Princeton.
- de Franciscis, A. 1963. 'Vetri antichi scoperti ad Erculano', *JGS*: 137–9
- DeLaine, J. 1997. *The Baths of Caracalla*. JRA supplementary series no 25. Portsmouth, Rhode Island.
- Dessau, H. 1892. *Inscriptiones Latinae Selectae*, volume I. Berlin
- Dickinson, B. & Hartley, B. 2000. 'The Samian', in Rush, P., Dickinson, B., Hartley, B. & Hartley, K.F. 2000. *Roman Castleford. Volume III: the Pottery*. Yorkshire Archaeology 6, West Yorkshire Archaeology Service, Wakefield: 5–88
- Edgar, C.C. 1905. *Catalogue général des Antiquités égyptiennes du musée du Caire. Graeco-Egyptian glass*. Imprimerie de l'Institut Français d'Archéologie Orientale, Cairo.
- Feugère, M. 1992. 'Un lot de verres du 1^{er} siècle provenant du Port de Narbonne (Aude) (sondages 1990–1992)', *Revue Archeologique du Narbonnais* 25: 177–206
- Feugère, M. & Leyge, F. 1989. 'La cargaison de verrerie augustéenne de l'épave de la Tradelière (Îles de Lérins)', in Feugère, M. (ed.) *Le Verre Préromain en Europe Occidentale*. Montagnac, Monique Mergoil: 169–76
- Follmann-Schulz, A.-B. 1991 'Fours de verriers romains dans la province de Germanie inférieure', in Foy, D. and Sennequier, G. (eds.), *Ateliers de verriers de l'Antiquité à la période pré-industrielle*. Actes de 4^{èmes} Rencontres (Rouen 1989). Association Française pour l'Archéologie du Verre, Rouen.
- Foy, D. 2000. 'Technologie, géographie, économie. Les ateliers de verriers primaires et secondaires en Occident esquisse d'une évolution de l'Antiquité au Moyen Âge', in Nenna, M.-D. (ed.) *La Route du Verre. Ateliers primaires et secondaires du second millénaire av.J-C. au Moyen Âge*. Maison de l'Orient Méditerranéen-Jean Pouilloux, Lyon: 147–70
- Foy, D. & Nenna, M.-D. 2001. *Tout Feu, Tout Sable. Mille ans de verre antique dans le Midi de la France*. Musées de Marseille. Aix en Provence, Édusud.
- Foy, D. & Sennequier, G. 1989. *À travers la verre du Moyen Âge à la Renaissance*. Musées et Monuments départementaux de la Seine-Maritime, Rouen.
- Foy, D. & Sennequier, G. 1991 *Ateliers de verriers de l'Antiquité à la période pré-industrielle*. Actes de 4^{èmes} Rencontres (Rouen 1989). Association Française pour l'Archéologie du Verre, Rouen.
- Freestone, I.C., Gorin-Rosen, Y. & Hughes, M.J. 2000. 'Primary glass from Israel and the production of glass in Late Antiquity and the Early Islamic period' in Nenna, M.-D. (ed.) *La Route du Verre. Ateliers primaires et secondaires du second millénaire av.J-C. au Moyen Âge*. Maison de l'Orient Méditerranéen-Jean Pouilloux, Lyon: 65–83
- Fremersdorf, F. 1938. 'Römische Gläser mit buntgefleckter Oberfläche', *Festschrift für August Oxé*. Darmstadt: 116–21
- Frere, S. 1987. 'Roman Britain in 1986: Sites explored', *Britannia* 18, 302–59
- Giacobelli, M. 1997. 'I vetri del rilitto di Grado', *Atti del Convegno Nazionale di Archeologia Subacquea* (Anzio 1996). Bari, Edipuglia: 311–3
- Gorin-Rosen, Y. 1993 'Hadera, Bet Eli'ezer', *Excavations and Surveys in Israel* 13, 42–3
- Gorin-Rosen, Y. 2000. 'The ancient glass industry in Israel; summary of the finds and new discoveries', in Nenna, M.-D. (ed.) *La Route du Verre. Ateliers primaires et secondaires du second millénaire av.J-C. au Moyen Âge*. Maison de l'Orient Méditerranéen-Jean Pouilloux, Lyon: 49–63
- Grose, D.F. 1974. 'Roman glass of the first century AD. A dated deposit of glassware from Cosa, Italy', *Annales du 6^e Congrès de l'Association Internationale pour l'Histoire du Verre* (Cologne 1–7 Juillet 1973), Liège: 31–52

- Hanel, N. 1995. *Vetera I. Die Funde aus den römischen Lagern auf dem Furstenberg bei Xanten*. Rheinische Ausgrabungen 35, Rheinland-verlag, Bonn.
- Harden, D.B. 1935. 'Romano-Syrian glasses with mould-blown inscriptions', *JRS* 25: 163–86
- Harden, D.B. 1936. *Roman glass from Karanis found by the University of Michigan Archaeological Expedition in Egypt 1924–29*. University of Michigan Press, Ann Arbor.
- Harden, D.B. 1958. 'Glass', in Hull, M.R. (ed.) *Roman Colchester*. Reports of the Research Committee of the Society of Antiquaries of London 20, Oxford: 157–8
- Harden, D.B. 1969. 'Ancient Glass, II: Roman' *AJ* 126: 44–77
- Hartley, K.F. 2000. 'The "Pottery Shop" Mortaria, in Rush, P., Dickinson, B., Hartley, B. & Hartley, K.F. (eds) *Roman Castleford. Volume III: the Pottery*. Yorkshire Archaeology 6, West Yorkshire Archaeology Service, Wakefield: 183–6
- Holwerda, J.H. 1933 'Der römische Sarkophag von Simpelveld', *Archäologischer Anzeiger. Beiblatt zum Archäologischer Instituts* 1933 I/II: 56–75
- Hull, M.R. 1958. *Roman Colchester*. Reports of the Research Committee of the Society of Antiquaries of London 20, Oxford.
- Isings, C. 1957. *Roman Glass from Dated Finds*. Wolters, Groningen.
- Isings, C. 1980. 'Glass from the *canabae legionis* at Nijmegen', *Berichten van Rijksdienst voor het Oudheidkundig Bodemonderzoek* 30: 281–346
- Jackson, C.M., Cool, H.E.M. & Wager, E.C.W. 1998. 'The manufacture of glass in Roman York', *JGS* 40: 55–61
- Jacobson, G.L. 1992. 'Greek names on prismatic jugs', *JGS* 34: 35–43
- Jashemski, W.F. 1979. 'The Garden of Hercules at Pompeii (II.viii.6): the discovery of a commercial flower garden', *AJA* 83: 403–11
- Kisa, A. 1908. *Das Glas im Altertume*. Hiersmann, Leipzig.
- Künzl, E. 1982. 'Medizinische Instrumente aus Sepulkralfunden der römischen Kaiserzeit', *Bonner Jahrbücher* 182: 1–131
- Lazar, I. 2004 'Spiegelungen der Vorzeit – Antikes Glas in Slowenien', in Lazar, I. ed., *Die Römer – Glas, Ton, Stein*. Pokrajinski Musej, Celje: 10–81
- Lehrer, G. 1979. *Ennion – a First-Century Glassmaker*. Museum Ha Eretz, Ramat Aviv.
- Leon, H.J. 1941. 'Sulphur for broken glass', *TPAPA* 72: 233–6
- Liversidge, J. 1955. *Furniture in Roman Britain*. Tiranti, London.
- Mazor, G. & Bar-Nathan, R. 1998. 'The Bet She'an Excavation Project – 1992–1994. Antiquities Authority Expedition', *Excavations and Surveys in Israel* 17: 7–37
- Millett, M. 1987. 'Boudicca, the First Colchester Potters' Shop, and the dating of Neronian Samian', *Britannia* 18: 93–123
- Motte, S. & Martin, S. 2003. 'L'atelier de verrier antique de la Montée de la Butte à Lyon et ses productions', in Foy, D. & Nenna, M.-D. (eds) *Échanges et commerce du verre dans le monde antique*. Actes du colloque de l'AFAV, Aix-en-Provence et Marseille 2001, Monographies Instrumentum 24, Montagnac, Monique Mergoil: 303–19
- Munier, C. & Brkojewitisch, G. 2003. 'Premiers éléments relatifs à la découverte récente d'un atelier de verrier antique à Besançon', in Foy, D. & Nenna, M.-D. (eds) *Échanges et commerce du verre dans le monde antique*. Actes du colloque de l'AFAV, Aix-en-Provence et Marseille 2001, Monographies Instrumentum 24, Montagnac, Monique Mergoil: 321–37
- Naumann-Steckner, F. 1991. 'Depictions of glass in Roman wall paintings', in Newby, M. & Painter, K. (eds) *Roman Glass: Two Centuries of Art and Invention*. Society of Antiquaries of London Occasional Paper no 13, London: 86–98
- Naumann-Steckner, F. 1999. 'Glasgefasse in der römischen Wandmalerei', in Klein, M.J. (ed.) *Römische Glaskunst und Wandmalerei*. von Zabern, Mainz: 25–33
- Nenna, M.-D. 2000. *La Route du Verre. Ateliers primaires et secondaires du second millénaire av.J-C. au Moyen Âge*. Maison de l'Orient Méditerranéen-Jean Pouilloux, Lyon.

- Nenna, M.-D., Picon, M. & Vichy, M. 2000. 'Ateliers Primaires et Secondaires en Égypte à l'époque Gréco-Romaine', in Nenna, M.-D. (ed.) *La Route du Verre. Ateliers primaires et secondaires du second millénaire av.J-C. au Moyen Âge*. Maison de l'Orient Méditerranéen-Jean Pouilloux, Lyon: 97-112
- Nordh, A. 1949 *Libellus de regionibus urbis Romae*. Gleerup, Lund
- Painter, K.S. 1968. 'Roman glass', in Harden, D.B., Painter, K.S., Pinder-Wilson, R.H. & Tait, H. *Masterpieces of Glass*. British Museum, London 36-90
- Parker, A.J. 1992. *Ancient shipwrecks of the Mediterranean and the Roman provinces*. BAR (International Series) 580, Oxford
- Peréz-Sala Rodés, M. 2001. 'El estudio del reciclaje del vidrio en el mundo romano: el caso de Guildhall Yard, Londres', in Carreras Rossell, T. (ed.) *I Jornades Hispàniques d'Història del Vidre: Actes (Sitges 2000)*. Museu d'Arqueologia de Catalunya, Barcelona 65-72
- Price, J. 1974. 'A Roman mould-blown negro-head glass beaker from London', *AntJ* 54: 291-2
- Price, J. 1981. *Roman glass in Spain*. Unpublished PhD thesis, University of Wales
- Price, J. 1988. 'An Egyptian terracotta group showing Eros beside a glass furnace', *AntJ* 68: 317-9
- Price, J. 1991. 'Decorated mould-blown glass tablewares in the first century AD', in Newby, M. & Painter, K. (eds) *Roman Glass: Two Centuries of Art and Invention*. Society of Antiquaries of London Occasional Paper no 13, London: 56-75
- Price, J. 1995. 'Glass vessels', in Manning, W.H., Price, J. & Webster, J. (eds) *The Excavations at Usk, 1965-1976. The Roman Small Finds*. Cardiff, University of Wales Press, Cardiff: 139-91
- Price, J. 1996. 'A ribbed bowl from a late Iron Age burial at Hertford Heath, Hertfordshire', *Annales du 13^e Congrès de l'Association Internationale pour l'Histoire du Verre (Pays-Bas 1995)*. Lochem: 47-54
- Price, J. 1998. 'The social context of glass production in Roman Britain', in McCray, P. (ed.) *The prehistory and history of glassmaking technology*. Ceramics and Civilisation 8, American Ceramic Society, Westerville, Ohio: 331-48
- Price, J. 2002. 'Broken bottles and quartz sand: glass production in Yorkshire and the North in the Roman period', in Wilson, P. & Price, J. (eds) *Aspects of Industry in Roman Yorkshire and the North*. Oxbow, Oxford: 81-94
- Price, J. & Cool, H.E.M. 1991. 'The evidence for the production of glass in Roman Britain', in Foy, D. & Sennequier, G. (eds) *Ateliers de verriers de l'Antiquité à la période pré-industrielle. Actes de 4^{èmes} Rencontres (Rouen 1989)*. Rouen, Association Française pour l'Archéologie du Verre, Rouen: 23-30
- Price, J. & Cottam, S. 2000. 'Glass tablewares in use at Mytilene in Lesbos in the early-mid 1st century AD', *Annales du 14^e Congrès de l'Association Internationale pour l'Histoire du Verre (Venise-Milan 1998)*. Lochem: 58-62
- Radić, I. & Jurišić, M. 1993. 'Das antike Schliffswrack von Mljet, Kroatien', *Germania* 71: 113-38
- Rush, P. 2000. 'The Coarse Wares', in Rush, P., Dickinson, B., Hartley, B. & Hartley, K.F. (eds). *Roman Castleford. Volume III; the Pottery*. Yorkshire Archaeology 6, West Yorkshire Archaeology Service, Wakefield: 89-166
- Rütti, B. 1991. *Die römischen Glaser aus Augst und Kaiseraugst*. Forschungen in Augst 13/1-2. Augst, Römermuseum.
- Sagui, L. 1998. *Storie al Caleidoscopio. I vetri della collezione Gorga: un patrimonio ritrovato*. Museo dell'Arte Classica, Rome.
- Sagui, L. 2000. 'Produzioni vetrarie a Roma tra V e VII secolo', *Annales du 14^e Congrès de l'Association Internationale pour l'Histoire du Verre (Italia/Venezia-Milano 1998)*: 203-7
- Sagui, L., Bacchelli, B. & Pasqualucci, R. 1996. 'Un patrimoine unique au monde. Les verres de la collection Gorga', *Annales du 13^e Congrès de l'Association Internationale pour l'Histoire du Verre (Pays Bas - 1995)*: 213-24
- Scatozza Horicht, L.A. 1986. *I vetri romani di Erculano*. Ministero per i Beni Culturali ed Ambientali Soprintendenza Archeologica di Pompei, Cataloghi 1, "L'Erma" di Bretschneider, Roma.

- Sear, F. 1976. 'Wall and vault mosaics', in Strong, D. & Brown, D. (eds) *Roman Crafts*. Duckworth, London: 231–240
- Sear, F. 1977. *Roman wall and vault mosaics*. F.H. Kerle, Heidelberg
- Sennequier, G. 1985. *Verrerie d'Époque Romaine. Collections des Musées départementaux de Seine-Maritime*. Rouen
- Sennequier, G. 1986. 'Un certain AMARANTUS (ou AMARANTHUS ?), verrier installé en Bourgogne au I^{er} siècle de notre ère', *JGS* 28: 11–18
- Shepherd, J. 1986. 'Glass', in Miller, L., Schofield, J. & Rhodes, M. (eds) *The Roman quay at St Magnus House, London. Excavations at New Fresh Wharf, Lower Thames Street, London 1974–8*. London and Middlesex Archaeological Society Special Paper no 8: 209–10
- Shepherd, J. & Heyworth, M. 1991. 'Le travail du verre dans Londres romain (Londinium): un état de la question', in Foy, D. & Sennequier, G. (eds) *Ateliers de verriers de l'Antiquité à la période pré-industrielle. Actes de 4^{èmes} Rencontres* (Rouen 1989). Rouen, Association Française pour l'Archéologie du Verre, Rouen: 13–22
- Steinby, E.M. 1999. *Lexicon Topographicum Urbis Romae, V*. Edizioni Quasar, Rome.
- Stern, E.M. 1995. *The Toledo Museum of Art. Roman Mold-Blown glass: the First through Sixth Centuries*. L'Erma di Bretschneider, Rome.
- Stern, E.M. 1999. Roman glassblowing in a cultural context. *AJA* 103: 441–84
- Sternini, M. 1994. 'Bottiglie in vetro con bolli greci', *Epigrafia della produzione e della distribuzione*. Collection de l'Ecole Française de Rome 193: 567–74
- Sternini, M. 1995. *La Fenice di Sabbia: storia e tecnologia del vetro antico*. Edipuglia, Bari.
- Stiaffini, D. 2000. 'Vetri', in Bruni, S. (ed.) *Le navi antiche di Pisa*. Edizioni Polistampa, Firenze: 264–89
- Swan, V.G. 1984. *The Pottery Kilns of Roman Britain*. Royal Commission on Historical Monuments Supplementary Series 5. Her Majesty's Stationery Office, London.
- Taborelli, L. 1996. 'I contenitori per medicamenti nelle prescrizioni di Scribonio Largo e la diffusione del vetro soffiato', *Latomus* 55: 148–56
- Tek, A.T. 2003. 'Prismatic glass bottles with Greek inscriptions from Arycanda in Lycia', *Annales du 15^e Congrès de l'Association Internationale pour l'Histoire du Verre* (New York-Corning 2001). Nottingham: 82–7
- Trowbridge, M.L. 1930. *Philological Studies in Ancient Glass*. University of Illinois Press, Urbana.
- von Massow, W. 1932. *Die Grabdenkmäler von Neumagen*. de Gruyter, Berlin.
- von Saldern, A. 1980. *Ancient and Byzantine Glass from Sardis*. Archaeological Exploration of Sardis Monograph no 6. Harvard University Press, Cambridge, MA.
- Wacher, J. 1978. *Roman Britain*. Dent, London.
- Wainwright, G.A. 1924. 'Roman glass from Kom Washim', *Le Musée Égyptien* 3.3: 64–97
- Wedepohl, K.H., Gaitzsch, W. & Follmann-Schulz, A.B. 2003. 'Glass-making and Glass-working in six Roman factories in the Hambach Forest, Germany', *Annales du 15^e Congrès de l'Association Internationale pour l'Histoire du Verre* (New York-Corning 2001). Nottingham: 56–61
- Weinberg, G.D. 1988. *Excavations at Jalame. Site of a glass factory in late Roman Palestine*. University of Missouri Press, Columbia.
- Whitehouse, D. 1999. 'Glass in the epigrams of Martial', *JGS* 41: 73–81
- Whitehouse, D. 2001. 'Window glass between the first and the eighth centuries', in Dell'Acqua, F. & Silva, R. (eds) *Il Colore nel Medioevo*. Istituto Storico Lucchese, Lucca: 31–43
- Whitehouse, D. 2003. 'A mould-blown bottle from the workshop of Titianus Hyacinthus', *JGS* 45: 179–80
- Yadin, Y. 1963. *The finds from the Bar Kokhba period in the Cave of Letters*. Israel Exploration Society, Jerusalem.